

WHAT IS CLAIMED IS:

1. A method of manufacturing a semiconductor device having a gate, a source and a drain within a single crystal semiconductor region, comprising:

a first step of pattern forming said gate above said single crystal semiconductor region through a gate insulating film;

a second step of introducing atoms to amorphize said single crystal semiconductor from oblique directions to a surface of said single crystal semiconductor region with said gate as a mask to form amorphous regions seeping into said single crystal semiconductor region under said gate;

before or after said second step, a third step of introducing impurities into the surface of said single crystal semiconductor region with said gate as a mask; and

a fourth step of activating said impurities by executing laser irradiation on at least said amorphous regions to form the source and the drain.

2. The method of manufacturing a semiconductor device according to claim 1, further comprising:

after said fourth step, a fifth step of forming a side wall insulating film on side surfaces of said gate and siliciding surface layers of the source and the drain with said gate and said side wall insulating film as a mask.

3. A method of manufacturing a semiconductor device having a gate, a source and a drain within a single crystal semiconductor region, comprising:

a first step of pattern forming said gate above said single crystal semiconductor region through a gate insulating film;

a second step of introducing atoms to amorphize said single crystal semiconductor from oblique directions to a surface of said single crystal semiconductor region with said gate as a mask to form first amorphous regions seeping into said single crystal semiconductor region under said gate;

before or after said second step, a third step of introducing impurities into the surface of said single crystal semiconductor region with said gate as a mask to form first junction regions;

a fourth step of forming a side wall insulating film on side surfaces of said gate;

a fifth step of introducing atoms to amorphize said single crystal semiconductor into the surface of said single crystal semiconductor region with said gate and said side wall insulating film as a mask to form second amorphous regions which are deeper than said first amorphous regions;

before or after said fifth step, a sixth step of introducing impurities into the surface of said single crystal semiconductor region with said gate and said side wall insulating film as a mask to form

second junction regions which are deeper than said first junction regions; and

a seventh step of removing said side wall insulating film and thereafter activating said impurities in said first and second junction regions by executing laser irradiation on at least said amorphous regions to form the source and the drain.

4. The method of manufacturing a semiconductor device according to claim 3, further comprising:

after said seventh step, an eighth step of forming again a side wall insulating film on the side surfaces of said gate and siliciding surface layers of the source and the drain with said gate and said side wall insulating film as a mask.

5. The method of manufacturing a semiconductor device according to any one of claims 1 to 3, wherein

an intensity of said laser irradiation is a value of conditions under which said amorphous semiconductor melts but said single semiconductor does not melt.

6. The method of manufacturing a semiconductor device according to claim 1, wherein

said gate insulating film is of one type selected from among a silicon oxide film, a silicon nitride film, a silicon oxynitride film and a metal oxide film having a dielectric constant higher than that of the silicon oxide film, or of a film having a laminated structure thereof.

7. The method of manufacturing a semiconductor device according to claim 1, wherein

a material of said gate is of one element selected from among silicon, germanium, silicon-germanium and metals.

8. The method of manufacturing a semiconductor device according to claim 1, wherein

said atoms to amorphize said single crystal semiconductor are of one element selected from among Si, Ge, As and Ar.

9. A method of manufacturing a semiconductor device, comprising the steps of:

introducing atoms to amorphize a single crystal semiconductor using a mask at least twice under different introduction conditions to form each amorphous region having a different depth and area in accordance with each introduction of said atoms;

introducing impurities for forming a pn junction before or after each introduction of said atoms; and

activating said introduced impurities by executing laser irradiation on at least said amorphous regions to form said pn junction.

10. The method of manufacturing a semiconductor device according to claim 9, wherein

at the occasion of the introduction of said atoms, said atoms are introduced from an oblique direction to a surface of said single crystal semiconductor region to seep into said single crystal semiconductor

region under said mask at least at one time of introduction of said atoms.

11. The method of manufacturing a semiconductor device according to claim 9, wherein

an intensity of said laser irradiation is a value of conditions under which said amorphous semiconductor melts but said single semiconductor does not melt.

12. The method of manufacturing a semiconductor device according to claim 9, wherein

said atoms to amorphize said single crystal semiconductor are of one element selected from among Si, Ge, As and Ar.

13. A method of manufacturing a semiconductor device having a gate, a source and a drain within a single crystal semiconductor region, comprising:

a first step of pattern forming said gate above said single crystal semiconductor region through a gate insulating film;

a second step of introducing atoms to amorphize said single crystal semiconductor into a surface of said single crystal semiconductor region with said gate as a mask to form amorphous regions;

before or after said second step, a third step of introducing impurities into the surface of said single crystal semiconductor region with said gate as a mask; and

a fourth step of activating said impurities by executing laser irradiation on at least said amorphous regions to form the source and the drain,

wherein conditions of introducing said atoms in said second step and conditions of intensity of the laser irradiation in said fourth step are controlled respectively to form parts of the source and the drain corresponding to said amorphous regions to seep into said single crystal semiconductor region under said gate.

14. The method of manufacturing a semiconductor device according to claim 13, wherein

a capacitance on said source side is $0.25 \text{ (fF/}\mu\text{m/side)}$ or more.

15. The method of manufacturing a semiconductor device according to claim 13, wherein

the conditions of introducing said atoms are conditions enough for said amorphous regions to seep into said single crystal semiconductor region under said gate, and the conditions of intensity of the laser irradiation are conditions for only said amorphous regions to melt but for said single crystal semiconductor region not to melt.

16. The method of manufacturing a semiconductor device according to claim 13, wherein

said atoms to amorphize said single crystal semiconductor are of one element selected from among Si, Ge, As and Ar.

17. The method of manufacturing a semiconductor device according to claim 13, wherein

at the occasion of said fourth step, a heat absorbing film is formed on the entire surface and the laser irradiation is performed through said heat absorbing film.

18. A method of manufacturing a semiconductor device having a gate, a source and a drain within a single crystal semiconductor region, comprising:

a first step of pattern forming said gate above said single crystal semiconductor region through a gate insulating film;

a second step of forming a side wall insulating film on side surfaces of said gate and introducing impurities to form deep, first junction regions;

a third step of removing said side wall insulating film and thereafter introducing atoms to amorphize said single crystal semiconductor into a surface of said single crystal semiconductor region with said gate as a mask to form amorphous regions;

before or after said second step, a fourth step of introducing impurities into the surface of said single crystal semiconductor region with said gate as a mask to form shallow, second junction regions; and

a fifth step of activating said impurities in said first and second junction regions by executing laser irradiation on at least said amorphous regions to form the source and the drain,

wherein conditions of introducing said atoms in said third step and conditions of intensity of the laser irradiation in said fifth step are controlled respectively to form parts of the source and the drain corresponding to said amorphous regions to seep into said single crystal semiconductor region under said gate.

19. The method of manufacturing a semiconductor device according to claim 18, wherein

a capacitance on said source side is $0.25 \text{ (fF}/\mu\text{m/side)}$ or more.

20. The method of manufacturing a semiconductor device according to claim 18, wherein

the conditions of introducing said atoms are conditions enough for said amorphous regions to seep into said single crystal semiconductor region under said gate, and the conditions of intensity of the laser irradiation are conditions for only said amorphous regions to melt but for said single crystal semiconductor region not to melt.

21. The method of manufacturing a semiconductor device according to claim 18, wherein

said atoms to amorphize said single crystal semiconductor are of one element selected from among Si, Ge, As and Ar.

22. The method of manufacturing a semiconductor device according to claim 18, wherein

at the occasion of said fifth step, a heat absorbing film is formed on the entire surface and the laser irradiation is performed through said heat absorbing film.

23. A method of manufacturing a semiconductor device having a gate, a source and a drain within a single crystal semiconductor region, comprising:

a first step of pattern forming said gate above said single crystal semiconductor region through a gate insulating film;

a second step of introducing atoms to amorphize said single crystal semiconductor from oblique directions to a surface of said single crystal semiconductor region with said gate as a mask to form amorphous regions seeping into said single crystal semiconductor region under said gate;

before or after said second step, a third step of introducing impurities into the surface of said single crystal semiconductor region with said gate as a mask; and

a fourth step of activating said impurities by executing laser irradiation on at least said amorphous region to form the source and the drain,

wherein in said second step, tilt angles of the introduction of said atoms with respect to a direction vertical to the surface of said single crystal semiconductor region are controlled to be greater on said source side than on said drain side

so as to form said amorphous regions such that an amount of seeping into said single crystal semiconductor region under said gate is greater on said source side than on said drain side.

24. The method of manufacturing a semiconductor device according to claim 23, wherein

a capacitance on said source side is $0.25 \text{ (fF}/\mu\text{m/side)}$ or more.

25. The method of manufacturing a semiconductor device according to claim 23, wherein

said atoms to amorphize said single crystal semiconductor are of one element selected from among Si, Ge, As and Ar.

26. The method of manufacturing a semiconductor device according to claim 23, wherein

at the occasion of said fourth step, a heat absorbing film is formed on the entire surface and the laser irradiation is performed through said heat absorbing film.

27. A semiconductor device having a gate, a source and a drain within a single crystal semiconductor region, wherein

the source and the drain are constituted by integrating a shallow junction seeping into said single crystal semiconductor under said gate and a deep junction extending under said shallow junction,

at least said shallow junction includes impurities and atoms to amorphize said single crystal semiconductor, and

a capacitance on said source side is $0.25 \text{ (fF}/\mu\text{m/side)}$ or more.

28. The semiconductor device according to claim 27, wherein

said atoms to amorphize said single crystal semiconductor are of one element selected from among Si, Ge, As and Ar.

29. A semiconductor device having a gate, a source and a drain within a single crystal semiconductor region, wherein

the source and the drain are constituted by integrating a shallow junction seeping into said single crystal semiconductor under said gate and a deep junction extending under said shallow junction,

at least said shallow junction includes impurities and atoms to amorphize said single crystal semiconductor, and

said shallow junction is formed such that an amount of seeping into said single crystal semiconductor region under said gate is greater on said source side than on said drain side, and a capacitance on said source side is $0.25 \text{ (fF}/\mu\text{m/side)}$ or more.

30. The semiconductor device according to claim 29, wherein

said atoms to amorphize said single crystal semiconductor are of one element selected from among Si, Ge, As and Ar.